NorCal HEP-EXchange

Saturday 02 December 2017 - Saturday 02 December 2017

Stanford University

Book of Abstracts

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Introduction and Welcome

Author: Lauren Tompkins[None]

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Works in Progress / **2**

Progress Towards the Direct Detection of sub-GeV Dark Matter Using a Superfluid He-4 Target

Author: Andreas Biekert[1]

Co-authors: Daniel McKinsey [1]; Junsong Lin [1]; Scott Hertel [2]; Vetri Velan [1]

[1] *UC Berkeley*

[2] *UMass Amherst*

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We propose a new detector design based on superfluid helium sensitive to the sub-GeV mass WIMP-like dark matter parameter space. Our detector design reads out roton and phonon excitations in the superfluid by detecting the quantum evaporation of helium atoms with bolometers suspended in vacuum above the superfluid helium mass. The binding energy from helium absorption to the bolometer surface allows for the amplification of excitation signals, giving us to access new parameter space with a kilogram-scale experiment. Bolometers submerged in the superfluid enclose the rest of the active mass to read out scintillation photons as another signal channel for discrimination. We discuss simulation work for predicting the sensitivity reach of this detector concept and ongoing efforts towards two neutron scattering experiments to characterize helium scintillation response to nuclear recoils.

Session:

Works in Progress (15+5 min)

Lightning Talks / **3**

First Evidence of the Solubility of Adsorbed Radon Daughters in Liquid Xenon

Author: Katayun Kamdin[None]

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Dual phase liquid/gas xenon time projection chambers (TPCs) currently set the worlds most sensitive limits on weakly interacting massive particles (WIMPs), a favored dark matter candidate. Radon and radon daughters produce problematic backgrounds for these searches. During detector construction,

222Rn and daughters plate out onto detector surfaces. While 222Rn has a half-life of 3.8 d, the long-lived daughter 210Pb (half life ~22.3 y) can be a source of background events in even the longest running searches. Of particular concern for liquid xenon dark matter detectors are the 'naked beta' decays of 210Pb and 210Bi. Rejection of these backgrounds relies solely on being able to distinguish electron recoils from nuclear recoils. Typically it is assumed that once 222Rn and daughters plate out, they remain stuck to the surface, where a fiducial volume cut will reject the 'naked beta' decays of 210Pb and 210Bi. However, evidence of 210Bi mobility has been observed in the liquid scintillator environment of the KamLAND detector. If radon daughters are soluble in liquid xenon, they pose a serious background distributed in the fiducial volume. We present studies performed on a xenon TPC test bed at LBNL, showing first evidence of the solubility of adsorbed radon daughters in liquid xenon.

Session:

Works in Progress (15+5 min)

Works in Progress / **4**

Recombination in liquid xenon using the Large Underground Xenon (LUX) Experiment

Author: Vetri Velan[1]

[1] *UC Berkeley*

Two-phase xenon time projection chambers are a leading strategy for dark matter direct detection experiments. Some of the leading limits in the field are from the Large Underground Xenon experiment (LUX), XENON1T, and PANDAX-II. These experiments operate by measuring the scintillation and ionization of xenon when an incident particle interacts in the medium, potentially including WIMPs. As a result, it is crucial to calibrate these detectors and understand the light and charge yields from nuclear recoils and electron recoils. This is complicated by the fact that when xenon atoms are ionized, the positive ions and liberated electrons can recombine to form more scintillation light, and the recombination fraction depends on factors such as energy deposited, electric field, and particle type. I will present work done on the second science search (WS2014-16) of LUX to explain how recombination is a function of both the electric drift field and the energy deposited by electron recoils.

Session:

Works in Progress (15+5 min)

Works in Progress / **5**

Studies of Pb-206 recoils in Liquid Xenon

Author: Daniel Naim[1]

[1] *UC Davis*

Corresponding Author: dnaim@ucdavis.edu

The Davis Xenon R&D platform (DAX) is a dual-phase time projection chamber (TPC), which is being used as a test bed system for doing xenon detector studies at UC Davis. One of the primary goals of DAX is to characterize a common class of backgrounds in noble element dark matter detectors –

heavy nuclei emitted as decay daughters of radon. This platform will help improve our understanding of low-energy nuclear recoils (NR), which is important for informing background models for future experiments. I will report on first measurements of Pb-206 recoils in DAX.

Session:

Works in Progress (15+5 min)

Works in Progress / **6**

The Argon Response to Ionization and Scintillation (ARIS) experiment

Author: Benjamin Schlitzer[1]

Co-author: Tessa Johnson [1]

[1] *UC Davis*

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The Argon Response to Ionization and Scintillation (ARIS) experiment was constructed to characterize the response of single-scatter nuclear and electronic recoils in liquid argon in support of experiments with a liquid argon target. A 0.5 kg active volume scintillation cell of liquid argon was exposed to the highly collimated and quasi-monoenergetic LICORNE neutron source at the Institute de Physique Nuclaire Orsay in Orsay, France. An array of liquid scintillator detectors was used to tag scattered neutrons and select nuclear recoil energies, with average energies between 7.14 and 117.78 keV measured. The relative scintillation efficiency of nuclear recoils was measured to high precision for both zero field and a range of applied electric fields. Results from the experiment will be presented.

Session:

Works in Progress (15+5 min)

Lightning Talks / **7**

Analog Front-end Electronics for the LZ Experiment

Author: Jyothisraj Johnson[1]

[1] *UC Davis*

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The LZ experiment will deploy approximately 500 photomultiplier tubes to collect light from its liquid xenon volume. The job of the front-end electronics will be to provide both excellent efficiency for single photon detection and a large dynamic range to accommodate the largest pulses from calibration sources. I will present the design of a dual gain amplifier, which will have different shaping times for the two outputs. A systematic transient, noise and gain and phase analysis of this modified version of the LZ amplifier will be discussed in this talk. Preliminary measurements from prototype boards will also be presented.

Session:

Works in Progress (15+5 min)

Works in Progress / **8**

Latest Results of EXO-200

Author: Michael Jewell[1]

[1] *Stanford*

Corresponding Author: mjjewell@stanford.edu

The EXO-200 Collaboration is currently searching for neutrinoless double beta decay using a liquid xenon (LXe) time projection chamber filled with ~150 kg of enriched Xe-136. Using the first two years of data it has provided one of the most sensitive searches for neutrinoless double beta decay. After a brief interuption in data taking caused by the temporary shutdown of its host facility, Phase-II running began in April 2016 with upgrades to front-end electronics and a radon suppression system. Presented here are the latest results of the collaboration including the new data taken with improved energy resolution.

Session:

Works in Progress (15+5 min)

Works in Progress / **9**

Overview of Dark Photon Search at UC Davis

Author: Benjamin Godfrey[1]

[1] *UC Davis*

Corresponding Author: bpgodfrey@ucdavis.edu

Astronomical and cosmological observations have provided glimpses of physics beyond the standard model. This has motivated the creation of many experiments primarily focusing on weakly interacting massive particles (WIMPs) and supersymmetry. The lack of results from this search suggests the search for alternative candidates.[1]
The dark photon is a hypothetical low-mass vector boson born out of quantum fluctuations at the time of inflation. Its ultralight mass warrants its description as a classical field. This field would kinetically mix with the electromagnetic field setting up the possibility of detection in the lab. [2] This talk is an overview of the dark radio setup (both current and future) at UC Davis looking for this dark photon. By hanging an antenna inside a shielded room and listening over a wide swath of frequency space, we can search down to new limits on both mass and coupling strength of this hypothetical ultralight dark matter candidate.

[1] S. Chaudhuri, P. W. Graham, K. Irwin, J. Mardon, S. Rajendran, and Y. Zhao. Radio for hidden-photon dark matter detection. Phys. Rev., D92(7):075012, 2015.

[2] P. W. Graham, J. Mardon, and S. Rajendran. Vector Dark Matter from Inflationary Fluctuations. Phys. Rev., D93(10):103520, 2016.

Session:

Works in Progress (15+5 min)

Thesis Presentations / **10**

Search for High-Mass Top Quark Resonances with the Compact Muon Solenoid

Author: Christine McLean[1]

[1] *University of California, Davis*

Corresponding Author: camclean@ucdavis.edu

I present a search for new massive particles decaying to a pair of top quarks with the CMS detector at the LHC. Proton-proton collision data recorded at a center-of-mass energy of 13 TeV is used. The search is performed by measuring the invariant mass distribution of the top-quark pair and testing for deviations from the expected Standard Model background. In the high mass ranges accessible by the LHC at these energies, the top quarks are produced with high transverse momenta: the products of hadronically decaying top quarks emerge as a single jet. Specific reconstruction algorithms and selections are employed to address the identification of boosted top quark signatures. The results are presented in terms of upper limits on the model cross section. Models of Randall-Sundrum Kaluza-Klein gluon and Z′ boson production are considered.

Session:

Thesis Presentations (30+10 min)

Works in Progress / **11**

Charge and light readout characterization in a prototype liquid xenon time projection chamber for nEXO experiment

Author: Gaosong Li[1]

[1] *Stanford University*

Corresponding Author: ligs@stanford.edu

The nEXO collaboration is designing a 5-tonne xenon time projection chamber (TPC) using enriched Xe-136 isotope to search for neutrinoless double beta decays. Both the light and charge signals from interactions in the TPC will be collected. nEXO collaboration is developing and testing new technologies to improve charge and light collections, which include using a new design of anode consisting of an array of tiles for charge readout and silicon photomultipliers for light readout. I will describe our R&D work on testing and characterizing these new components in a prototype liquid xenon TPC.

Session:

Works in Progress (15+5 min)

Works in Progress / **12**

HGTD project for HL LHC

Author: Mazza Simone Michele[1]

[1] *UCSC*

Corresponding Author: simazza@ucsc.edu

In 2014-2025 the ATLAS detector at LHC (CERN, Geneva) will be upgraded to withstand the high pileup expected at HL-LHC. The inner tracker will be completely renewed with the ITk project and other parts detectors will be upgraded. HGTD will probably be included in the list of upgrades, it consist in 4 (yet to be confirmed) layers of pixel LGADs detectors in the pseudorapidity region of 2.4 to 4.2. LGADs (low gain avalanche detectors) are silicon detector with an additional multiplication layer with gain of ~10, thanks to the high rise of the signal pulse these detector can reach the exceptional time resolution of 30ps. In the talk a brief summary of the HGTD project will be given alongside the physics motivations, a part of the talk will be dedicated to LGAD technology.

Session:

Works in Progress (15+5 min)

Works in Progress / **13**

Light Collection Efficiency in SUE, The Phase 1 of the SLAC LZ System Test Platform

Author: Thomas Whitis[1]

[1] *SLAC*

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Phase 1 of the LZ system test platform is a two phase TPC used to test high voltage performance and other sub-systems for the LZ detector. The design and aspect ratio of this detector at ~ 50 cm in height and only 14 cm in diameter, make the photon detection efficiency vs. height highly sensitive to the reflectivity of the Teflon in both gas and liquid xenon. Using S1 only data taken with a Cs-137 source, at multiple positions along the TPC, I measured the photon detection efficiency as a function of the height in the TPC, and found a good match to simulations of the light propagation in the detector.

Session:

Works in Progress (15+5 min)

Lightning Talks / **14**

Noble Element Simulation Technique v2

Author: Jacob Cutter[1]

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Corresponding Author: jecutter@ucdavis.edu

The Noble Element Simulation Technique (NEST) software package provides a method for calculating light and ionization yields in noble element-based detectors. Since its introduction in 2011, results from various experiments have enabled improvements to NEST's underlying models. This talk introduces NEST2, a new version that implements these upgraded models, along with software improvements for better functionality and accessibility. This talk validates NEST2 against several experiments and highlights its usefulness for optimizing detector parameters and cross-checking analysis efforts. NEST2 will soon be available with a variety of interaction types in xenon, for recoils from 0.1-5,000 keV and electric fields from 0-5,000 V/cm.

Session:

Works in Progress (15+5 min)

15

Validating the LZ design with SUE: Phase I of the LZ System Test platform at SLAC

Author: Kelly Stifter[1]

[1] *SLAC/Stanford*

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LZ is a next generation dark matter search experiment designed to significantly extend our sensitivity to WIMP dark matter candidates. At the core of LZ is a dual-phase Xe time projection chamber (TPC) with a 7 ton active volume. A cryogenic test platform with ~100 kg of liquid Xe, including a 50 cm tall TPC, has been constructed at SLAC to test multiple subsystems at scales approaching or comparable to LZ. The platform focuses on high voltage performance of the TPC and on the Xe circulation and purification system, and also provides an opportunity to test the integration of other subsystems. An overview of the test platform will be presented with a particular focus on new solutions to previously observed problems with unexpectedly high signal rates in the detector and instabilities discovered in the Xe flow path - both of which have prompted design changes in LZ.

Session:

Works in Progress (15+5 min)

Works in Progress / 16

Update on the Cathode High Voltage Research and Development for LUX-ZEPLIN

Author: James Watson[1]

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Corresponding Author: watson_james@berkeley.edu

The LUX-ZEPLIN (LZ) experiment is a 7-ton active mass dual phase xenon time projection chamber that will be used to perform a direct search for Weakly Interacting Massive Particles (WIMPs), a dark matter candidate, as well as perform other physics searches. Incoming particles (such as a dark matter WIMP) interact with the xenon nuclei or electrons, inducing ionization and scintillation. An applied electric field guides the ionized electrons to a region of gaseous xenon across 1.456 meters of highly pure liquid xenon. PMT arrays on the top and bottom of the chamber detect the scintillation

light. An even stronger field extracts the electrons from the liquid-gas interface, producing secondary electroluminescence delayed by the drift time (maximum ~800 us). The electric field within the drift region is to have a strength of 0.65 kV/cm. The maintenance of this field without causing either breakdown or trace light is a design challenge. A significant part of that challenge comes from the method of delivering the high voltage (-100 kV) through a feedthrough from outside the TPC to the cathode, without spoiling purity of the xenon, drastically increasing the radioactive background, or creating spurious light. Here I present the status of LZ's Cathode High Voltage feedthrough (CHV) research and design project.

Session:

Works in Progress (15+5 min)

Lightning Talks / **17**

Development of the LZ High Voltage Grids

Author: Ryan Linehan[1]

[1] *SLAC*

The LZ experiment's hunt for dark matter relies on a set of uniform electric fields to produce measurable signals for WIMP-xenon interactions. To establish these fields, LZ will use four woven mesh high voltage grids set at different heights in the detector. Because of both the large 1.5-meter diameter of these grids and the strong electric fields on the wire surfaces, a considerable amount of R&D is required to ensure that they are built in a way that satisfies LZ's physics goals. This talk will discuss the grid development process and highlight a few of the current R&D efforts for optimizing grid construction and treatment prior to installation into LZ.

Session:

Works in Progress (15+5 min)

Works in Progress / **18**

Ultra-low background assays at LBNL and SURF

Author: Kelsey Mallory[1]

Co-authors: Andrew Cole [1]; Brianna Mount [2]; Kevin Lesko [3]

[1] *Lawrence Berkeley National Laboratory*

[2] *Black Hills State University*

[3] *LBNL*

Next generation dark matter and neutrino experiments seek to reach unprecedented sensitivities to new physics processes, requiring high levels of radiopurity in detector components. To aid in material selection, the Berkeley Low Background Facility (BLBF) provides a variety of advanced gamma spectroscopy services. We will present a general overview of the facilities at Lawrence Berkeley National Laboratory (LBNL) and the Black Hills Underground Campus (BHUC) on the 4850 ft level of the Sanford Underground Research Facility (SURF), including assay activities and techniques. We will summarize currently installed and future counting stations, focusing in particular on Morvydd and Owain (the Twins), a pair of new high sensitivity counters using a large germanium mass to achieve field-leading performance.

Session:

Works in Progress (15+5 min)

Lightning Talks / **26**

Same Sign WW Production at sqrt(s)=13 TeV with the ATLAS Detector

Author: Emily Duffield[None]

Same sign WW boson pairs produced in association with two or more jets (ssWWjj) is a Standard Model process that is sensitive to the mechanism of electroweak symmetry breaking as well as beyond the standard model physics, particularly through one of its production mechanisms, vector boson scattering (VBS). Due to the favorable ratio of electroweak production compared to strong production and the characteristic event topology of the process, ssWWjj production is ideal for studying VBS. The first evidence of same sign WW production was seen by the ATLAS collaboration in 20.3 inverse fb of 8 TeV data, seeing an excess in data of 3.6 sigma over backgrounds [1]. In this talk, the ongoing effort of observing ssWWjj production with 36 inverse fb of 13 TeV data collected with the ATLAS Detector is discussed.

[1] arXiv:1405.6241 [hep-ex]

Session:

Lightning Round (5+3 min)

Lightning Talks / **27**

Distributed Imaging for Liquid Scintillation Detectors

Author: Jacopo Dalmasson[1]

Co-author: Giorgio Gratta [1]

[1] *Stanford*

Abstract: We discuss a novel paradigm in the optical readout of scintillation radiation detectors. In one common configuration, such detectors are homogeneous and the scintillation light is collected and recorded by external photodetectors. It is usually assumed that imaging in such a photon-starved and large-emittance regime is not possible. Here we show that the appropriate optics, matched with highly segmented photodetector coverage and dedicated reconstruction software, can be used to produce images of the radiation-induced events. In particular, such a 'distributed imaging' system can discriminate between events produced as a single cluster and those resulting from more delocalized energy depositions. This is crucial in discriminating many common backgrounds at MeV energies. With the use of simulation, we demonstrate the performance of a detector augmented with a practical, if preliminary, set of optics. Finally, we remark that this new technique lends itself to be adapted to different detector sizes and briefly discuss the implications for a number of common applications in science and technology.

Session:

Lightning Round (5+3 min)

Lightning Talks / **28**

Generalized Numerical Inversion for Calibration

Author: Aviv Cukierman[1]

[1] *Stanford*

In ATLAS we use a sequential jet calibration for jet pT, including a numerical inversion to correct for the detector jet energy scale. Although a sequential jet calibration allows for careful understanding of the various factors that affect the jet energy scale, and allows for significantly reduced MC stats requirement than a global fit, it ignores possible correlations between the features that a multivariate approach might be better suited to handle. However previous efforts to derive a multivariate jet calibration (i.e. with machine learning) have been stymied by the preference that the overall calibration be independent of the underlying truth pT distribution used to train the calibration. Numerical inversion in particular is used exactly because it is independent of the underlying truth pT distribution. "Generalized numerical inversion" is a new idea for a multivariate numerical inversion framework that has potential to account for correlations between features, while still taking advantage of numerical inversion's independence from the underlying training distribution and also without increasing the MC stats requirement. Successful implementation of this technique, which is still in nascent stages, could improve the overall jet resolution in ATLAS and help understand what factors affect the jet resolution.

Session:

Lightning Round (5+3 min)

Lightning Talks / **29**

Tracking inside dense environments with ATLAS

Corresponding Author: wpmccormack@lbl.gov